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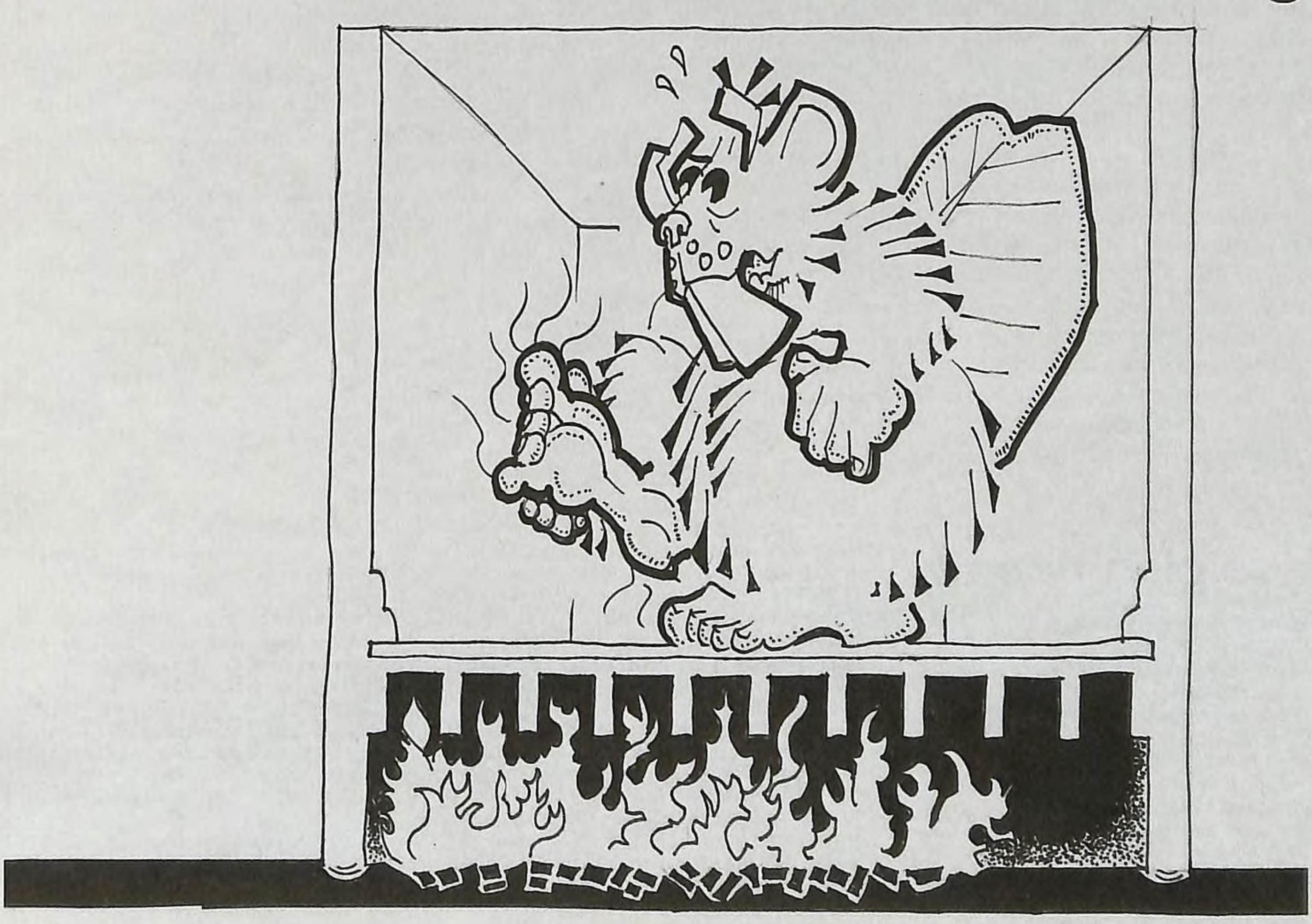
Inside . . .

Fire Resistance Testing



From The Editor . . .

Those of us of a certain age can remember traipsing to libraries and showrooms and tradeshows to glean the latest information about new products or techniques. The mailman trudged through rain, sleet and snow to deliver mounds of brochures, magazines and catalogues that provided valuable information. These were supplemented by technical sales representatives who knocked on doors and went to job sites.

Roving sales reps may seem quaint in the digital age, but they did something that no amount of electronic communication can – they not only sold their product, but also observed physical conditions so they often were important disseminators of knowledge, biased though it might have been. They also were able to communicate observations and on-site concerns back to the manufacturers and others.

In a very short time we have become very used to the Internet, and what it can do.

It is an extremely powerful communications tool and information source. Information can be exchanged very quickly, without any physical limitations. Today, there are few technical representatives out in the field and everyone seems to rely on the computer screen to deliver information. Product information catalogues are a natural for the Internet – easy to access and to update.

Although heat, air and moisture flows follow basic scientific principles, the context is all important. In the construction sector, site-specific issues are more important than in most other industrial sectors. Climatic conditions can be significantly different even within a very small geographical area. Even within a single building there can be vastly different conditions.

However, the digital world knows no borders. It can be accessed from virtually anywhere. It's great for communications, but I've noted that forums can also be extremely distracting and create confusion when opinions and ideas are expressed as facts without a full understanding of the context.

Science fundamentals may be straightforward and beyond reproach, but especially in the case of buildings, the context is very important. Discussions about a product and its problems don't always take into account the many related products and issues that may be involved. Often these included people with less than a complete understanding of the technical issues – and there is no way of knowing the background of the individual commentators to know how much credibility to assign them.

Recently, I've been alerted to discussions about the use of some insulation products, and concerns about indoor air quality and health concerns, but there was little reference to the climate in which the buildings were located, occupancy patterns, whether or not they were airtight, whether there was any ventilation in the building, and so on – all factors that need to be considered, rather than analyzing a product in isolation.

In Canada, although we have a fairly uniform building code largely based on considered evidence and building science principles, there are significant differences in construction practices and detailing used to build our homes under the same code. While most construction materials are widely used across the country, how they are detailed in specific applications may need to vary. And differences in detailing can be quite significant.

On-line discussions can be useful but must not be taken as absolute fact unless the authors and participants are known so that their credibility can be assessed.

Richard Kadulski,
Editor

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Fire Resistance Testing Of Floor Assemblies

Not all traditional floor assemblies have been performance tested for all their characteristics. Because their detailing has evolved, and have performed well, they are accepted even without full testing. In recent years, new construction materials and construction practices have been developed to meet demands for better acoustic separation as well as to incorporate new materials.

The new assemblies may have different assembly performance characteristics compared to that of traditional construction. Fire-fighters especially have expressed concern about the fire resistance of floor assemblies built with the new products. This has led the National Research Council of Canada (NRC), in collaboration with industry and government partners, to do research to measure the acoustic and fire performance of floor assemblies to update information contained in the National Building Code appendix.

The objectives of the research were to reaffirm existing fire resistance ratings in the current NBCC and to develop cost-effective and innovative floor assemblies.

Thirty-two full-scale tests were conducted at the Institute for Research in Construction (IRC) and the fire resistance measured. Three types of framing were used:

- 2x10 solid wood joists (SPF S-Dry),
- 10-inch deep wood-I-joists (from several suppliers) including lumber and laminated veneer lumber (LVL) with plywood and OSB webs, and
- C steel joists, nominal 2x8 (18 gauge)

The subfloors were either 19 mm OSB or 15.9 mm tongue and groove softwood plywood.

On the underside, type X gypsum board was used in two thicknesses: 12.7 mm (½") and 15.9 mm (5/8") thick. Three types of insulation were used: 3 ½" thick glass fibre; rock-wool insulation; or 59 mm to 122 mm thick wet-sprayed cellulose fibre insulation.

Nine thermocouples were installed on the unexposed surface to measure the surface temperature. The assembly was considered to have failed if a single point temperature reading measured by one of the nine thermocouples rose 180°C above the ambient temperature, or if the average temperature measured by the 9 thermocouples on the unexposed surface rose 140°C above the ambient temperature, or if there was passage of flame or gases hot enough to ignite cotton waste.

Based on the results from the tests, the following conclusions can be drawn:

Sub-floor

The type of sub-floor did not affect the fire resistance of the assembly.

Ceiling Under

The finishes on the underside of floor joists and how they are fastened do impact the fire performance. A second layer of gypsum board to a floor assembly with a single layer gypsum board ceiling finish significantly increases the fire resistance of an assembly.

The fire resistance can be further improved by locating the screws at the butt ends further away from the gypsum board edges by 50% (38 mm versus 10 mm). The explanation for this is that the gypsum board core has less free and crystallized water at the board edges than in the field of the board due to the drying process during manufacturing. Thus the board shrinks faster at the edges than in the field of the board. In addition, the heat transferred by the screws causes the edges of the board to pull away earlier from the joists in the assembly with the screws 10 mm from the board edges.

Joist Type

For non-insulated wood-I-joist assemblies, the joist flange configuration and size affected the fire resistance. Assemblies with a double layer of gypsum board and no insulation had these results:

- 38 mm x 38 mm LVL flange with plywood joist provided 69 minutes fire resistance
- 38 mm wide x 64 mm deep lumber flange with OSB web provided 74 minutes fire resistance

- wood I joists with 64 mm wide x 38 mm deep flanges provided 80 minutes fire resistance.

Effect of Insulation

Insulation is placed in floor assemblies primarily for acoustic reasons. The insulation also has an impact on the fire performance of the assembly – some counter-intuitive.

Wood Joist Assemblies

In assemblies with solid wood joists and a single layer gypsum board ceiling finish, glass fibre insulation reduced the fire resistance by about 20% while rock and cellulose fibre insulation increased the fire resistance by about 31%.

For assemblies with a double layer gypsum board ceiling finish, the installation of insulation in the floor cavity reduced the fire resistance by 16% for an assembly with glass fibre insulation, by 10% for an assembly with rock-wool insulation and by 7.5% for an assembly with cellulose fibre insulation compared to an assembly with no insulation in the floor cavity.

The negative effects of the fibre insulation is because the reduction in heat transfer from the gypsum board to the cavity caused the gypsum board to fail faster than the non-insulated assembly. In addition, the glass fibre melted within 2 to 3 minutes after the gypsum board fell off and was unable to compensate for the early failure of the gypsum board.

The structural load imposed on the assembly (75% and 100% of maximum design load) did affect the fire resistance of solid wood joist assemblies.

Floor Assemblies with Wood-I-Joists

In floor assemblies with wood-I-joists and a single layer gypsum board ceiling finish, the fire resistance increased by 10% when rock-wool insulation was used and by 24% with cellulose fibre insulation compared to an assembly with no insulation in the floor cavity.

In floor assemblies with a double layer gypsum board ceiling finish, glass fibre insulation reduced the fire resistance by 7% but rock-wool insulation increased the fire resistance by 7%.

As with solid wood joist assemblies, in wood-I-joist assemblies with rock-wool and cellulose fibre insulation there was a rapid increase in temperature on the gypsum board surface facing the cavity, compared to that measured for a non-insulated assembly. The temperature increase caused the gypsum board to fail earlier in the insulated assemblies, although both insulation products remained in place after the gysum board fell off so they were able to compensate for the early failure of the gypsum board and protected the wood joists and sub-floor for a substantial period.

A double layer gypsum board ceiling finish provided a significant increase in the fire resistance compared to an assembly with a single layer gypsum board. The additional layer of gypsum board provided longer fire protection to the joists because of the reduction in the temperature measured on the gypsum board surface facing the cavity compared to an assembly with a single layer of gypsum board.

The fire resistance was better in floors with wider wood-I-joist spacing – 24 inches compared to 16 inches on centre.

Steel Joist floors

In steel joist floor assemblies with a double layer gypsum board ceiling finish, the installation of glass fibre insulation in the floor cavity reduced the fire resistance by 8% compared to an assembly with no insulation in the floor cavity. This negative effect on the fire resistance is due to a reduction in the heat transfer from the gypsum board to the cavity, which increased the temperature of the gypsum board surface facing the cavity compared to a non-insulated assembly.

Spacing of steel joists did not affect the fire resistance.

Adding concrete topping to an assembly with steel joists and a double layer of gypsum board ceiling finish reduced its fire resistance.

A steel/concrete composite floor protected by two layers of gypsum board provided 105 minutes fire resistance.

Resilient Channels

Resilient channels are used to improve the acoustic performance in floor assemblies.

In a wood-I-joist assembly with two layers of gypsum board, a wider channel spacing (24 inches vs 16 inch) had lower fire resistance. This is largely because of the reduced number of fasteners for the gypsum board. With the increased number of screws, the gypsum board remained in place longer protecting the joists and increasing the fire resistance.

Assembly	Cavity insulation	Load (psf)	Fire resistance (minutes)
2x10 Wood joists @ 16" o/c			
5/8" plywood sub-floor, 1 layer 5/8" type X gypsum board ceiling	None	40	33
5/8" plywood sub-floor, 1 layer ½" Type X gypsum board ceiling; resilient channel @ 16"	none	80	45
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	None	80	80
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" Rock-wool	80	72
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	Wet spray cellulose	80	74
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" glass fibre	80	67
5/8" plywood sub-floor, 1 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" glass fibre	80	36
2x10 wood I Joist @ 16" o/c			
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	none	80	74
5/8" plywood sub-floor, 1 layer ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	none	96	42
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" glass fibre	82.5	64
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" Rock-wool	82.5	77
2x10 wood I Joist @ 24" o/c			
¾" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" glass fibre	52	74
2x8 steel joist @ 16" o/c			
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	none	61.5	74
5/8" plywood sub-floor, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" glass fibre	61.5	68
5/8" plywood sub-floor, 1 layer ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	3½" Rock-wool	61.5	46
Steel-concrete composite, 2 layers ½" Type X gypsum board ceiling, resilient channel @ 16" o/c	none	100.5	105

Effect of Concrete Topping

Tests on the steel joist assemblies found that concrete topping reduced its fire resistance from 68 minutes for an assembly without concrete topping to 60 minutes. This happened because, by adding concrete topping, the thermal resistance was increased and thus, reduced the heat transfer across the assembly. As a result, the temperature on the gypsum board base layer surface facing the cavity increased more rapidly and consequently, fell off earlier than in the assembly with no concrete topping.

However, the fire resistance of a steel/concrete composite floor assembly protected with two layers of gypsum board was found to provide a 105 minutes fire resistance. The gypsum board base layer remained in place for approximately 20 minutes after the face layer fell off. In this case, the concrete acted as a heat sink. ☼

Results of Fire Resistance Tests on Full-Scale Floor Assemblies

By M.A.Sultan; Y.P.Séguin; P.Leroux. Institute for Research in Construction National Research Council of Canada Research paper No. IRC-IR-764

Windows and Fire Performance of Houses

Fire spread between houses is a major underlying concern behind building regulations. Since windows are transparent, and permit radiant energy to flow through them, they represent the weakest element in the building from an energy and fire safety perspective. That is why building codes define limits for the maximum allowable window area on walls in close proximity to adjoining buildings.

With closely spaced houses in cities, the spatial separation between houses often becomes a key design determinant. There is a perpetual struggle to maximize window size to make rooms habitable while maintaining safety for the buildings. The question is what is an acceptable limit? What is the risk associated with the windows? The building code sets maximum limits on allowable window area as a ratio of the wall area and depending on the distance between buildings – the closer together the buildings are, the fewer windows are permitted – but if the building has sprinklers, the allowable window area can be doubled.

With more small lot subdivisions with small sideyards between houses, and proposals made to further reduce windows in sidewalls, there are concerns about the impact on workable home designs. That is why builders in Edmonton teamed up with window manufacturers to do full scale testing of walls to determine what impact windows have on the heat transfer between closely spaced houses.

Full-scale wall panels were built in Edmonton – they had OSB exterior sheathing painted with an intumescent coating, 5/8 Type X gypsum board, and metal clad low-e triple glazed windows. The panels were then shipped to Intertek's San Antonio, Texas fire laboratory for testing.

The results showed that metal clad, argon-filled, triple-paned windows contained the test fire within the building for 10 minutes. The opposite wall (with a window) that was 2.4 metres (8 feet) away did not suffer fire damage – the same wall panel was used in three separate tests. On the target wall window, the exterior 2 panes of glass broke, but not the third pane during a 20-minute test period.

The tests show that triple glazed windows are not only beneficial from an energy efficiency perspective, but also fire safety. They have already enabled builders in Edmonton to obtain variances to include windows in walls between closely spaced houses.

It is expected that the test results will be formalized in a report that should be able to contribute valuable information for regulatory bodies.

Future Energy Benchmarks for LEED Canada for Homes

Just a couple of years after launch, LEED Canada for Homes is growing well with over 1600 registered homes and almost 200 certified homes to date. With this success, LEED Canada for Homes is responding to calls from builders and developers to improve along with them. LEED Canada for Homes will be consulting this winter on raising the minimum energy efficiency threshold for participation in the program. Of the almost 200 homes certified to date, 98% have achieved EnerGuide 80 (or the US HERS / prescriptive point equivalent) and some in the field have been asking for the minimum EnerGuide bar to be raised.

The industry is indeed moving forward. The CaGBC is pleased to see that some provinces are adopting new building codes that take energy into account where they previously did not, and others are increasing the stringency of their codes. There is more to be done however, for there are still provinces that do not have what could be called a "modern" energy code.

Some provinces have started to claim equivalency between prescriptive energy codes and the model performance-based EnerGuide scale. Recently the City of Vancouver worked with Greater Vancouver Homebuilders and E3 EcoGroup to see how a prescriptive equivalent measured up in real world conditions. After studying about 300 homes, they concluded prescriptive codes lagged 3-4 points behind. What this means in practice is that an average home built to a provincial energy code that aims for an EnerGuide 80 equivalent will likely perform at or close to EnerGuide 76. This should be taken into consideration when evaluating the appropriate future energy threshold for LEED Canada for Homes, specifically in the context that the program aims to advance the industry while ensuring that the minimum performance benchmarks are achievable, with a reasonable degree of effort, in every province.

As a national third party verified rating system, we would like feedback from across the country to shape the progress of LEED Canada for Homes for the hundreds of builders involved. Please keep an eye out this winter for your opportunity to participate in the consultation process and have your say on how you would like to see energy efficiency improve. Notice will be posted at: *www.cagbc.org/homes*.

CaGBC also welcomes feedback at any time – simply contact *info@cagbc.org*.

You Asked Us About: Humidity Problems Inside the House

We have a humidity problem with one of our homes. The inside of the windows frequently get frost on the bottom 6 inches or so. What relative humidity level can be expected inside the house, and should we be getting someone to come to measure humidity levels?

The house was built eight years ago but similar situations are showing up in other homes by local builders so we want to get a handle on this situation. The homeowner did not want to upgrade to an HRV so the ventilation in the house is the code-mandated bathroom fan meeting minimum code requirements. Is there a retrofit HRV or dehumidifier that might work to solve the problem?

Humidity levels vary over the year and with differing climate conditions. If you are seeing humidity on the windows, it means that the house can't take any more moisture - it becomes self-limiting that way.

Higher performance windows with insulating spacers and insulating frames will permit higher moisture levels in the house than metal windows or windows with metal spacers (hence the cold edges) can tolerate.

Measuring humidity levels really won't tell you much because it varies constantly. Relative humidity (RH) describes the amount of water vapour in the air compared to the amount of moisture that air could hold if it is saturated. In cold weather, outdoor air may be saturated – outdoor air often approaches 100% RH, but cold air is not capable of holding much moisture. When that cold air is heated (as it is when introduced inside a heated building) the amount of absolute moisture is the same but the RH drops because warm air is able to hold more moisture.

If there are temperature variations in the house, such as cooler areas adjacent to windows compared to a well-insulated wall or a warmer interior space, you may notice some variation in the RH within the house. Any cold surfaces, such as windows of thermal bridging through framing, will allow condensation to take place on those areas.

You don't really need to get a specialist to test the condition – a simple humidity gauge available at a home electronics or hardware store will let you see what the humidity is on those days when there is a lot of condensation or frost. A few readings on other days as well would tell you what the average conditions are. If the humidity readings are in the 50-60% range, then there are obviously some concerns you want to investigate – whether it's a leak somewhere, a moisture source, or lifestyle issues. However, in most houses the humidity will likely be in the range of 25 to 40%.

If the house is fairly airtight, there will be less passive air change in the house, thus keeping indoor humidity levels higher. Lifestyle of the occupants will also be a contributing factor to indoor RH levels.

Frost on windows often tells us that the house was built reasonably airtight.

Ventilation is a major mechanism for controlling indoor humidity. Heat recovery ventilators are effective at providing air change for fresh indoor air while recovering energy.

There is no simple way to retrofit an HRV, although in a house with forced warm air heating, a simplified HRV installation could help provide some air change. The simplified HRV installation exhausts indoor air by taking some air from the return air stream of the furnace and supplies fresh air to the return air, downstream of the exhaust point. This provides air change for the house, and could help control humidity, although the ventilation itself will not provide optimum

ventilation for indoor air quality. However, it is important that the HRV unit and the furnace run continuously.

An alternate way to provide some air change is to make sure that the principal exhaust fan is run continuously, or at least 8 to 12 hours per day. If these fans are quiet enough (less than 1 sone) then there is less likelihood of the occupants shutting them off to reduce noise.

A dehumidistat control on the fans is another option although their calibration is not very precise and most homeowners are not sure how to set them, so the fan may not be run as much as it should. If the dehumidistat is set to avoid condensation on the windows on those very cold days, chances are the house may be much too dry the rest of the time.

You Asked Us About: Indoor Air Quality

We recently completed a house that was built in accordance with Built-Green criteria. We used low emission materials wherever possible and installed a heat recovery ventilator (HRV). The house has a forced warm air furnace.

The new homeowners have been in the house a couple of months now and are complaining about air quality in the house. They complain about burning eyes and stuffy conditions in the house. They now want indoor air quality testing to be done.

What could be the problem?

Without a detailed review of the house it is difficult to offer possible solutions. Just because low emissions materials were used, an HRV was installed, and it was built in accordance with green building program standards, there is no guarantee that indoor air quality will be superior or even acceptable.

One important task that is seldom done in construction is proper commissioning of systems – this means testing and verifying to make sure that all systems perform as intended. In the case of mechanical systems – furnaces and HRVs – it means taking measurements to ensure that there are adequate air flows and that controls work as intended.

In your case, there are a few possible issues that should be considered.

You indicate that an HRV was installed. You should check to make sure that it is running, and that it is drawing exhaust air from the bathrooms and kitchen area.

A simple test is to take a sheet of 2-ply toilet tissue and hold it up against the grille. If the tissue is sucked towards the duct in the exhaust grilles, then there would appear to be a reasonable exhaust air flow. If the tissue stays limp, it is a sign that there is very little, if any, airflow through the grille. In that case you should have a mechanical contractor or consultant take a measurement of how much air is being pulled through the grille to confirm that it is capable of drawing air.

Total house ventilation airflow requirements are quite small. A typical three bedroom house with three bathrooms, a study and finished rec room in the basement requires a ventilation system with a capacity of around 120-140 cfm, which would be running continuously at around 60 cfm. These are very small volumes of air, and are irrespective of how big the house may be, but because the ventilation system is running continuously, it will provide the required air change and should deal with most air quality concerns.

If there is not enough draw from the exhaust grille, it could be the result of a number of issues, including:

closed dampers in the HRV ducts

leaky ducts that do not allow much draw from the grilles

poor duct layout design

clogged filters or core in the HRV

plugged exhaust hood on the exterior.

Some of these possible issues are maintenance and commissioning issues, and some are more fundamental design and installation issues. This is why an inspection of the system should be done prior to drywall so that any possible defects could be identified and corrected while the system is accessible.

If the HRV system is tied to the forced warm air furnace for the distribution, then the furnace fan should be set to run continuously. If it is not, then there won't even much distribution of the fresh air that may be coming into the house through the HRV. Although this would not automatically deal with all the air quality and ventilation concerns, it would nevertheless allow some fresh air to be circulated through the house.

One other, not insignificant issue is to look for something in the house that could be contributing to poor indoor air quality – this could include a leak somewhere in the house, or articles that have been brought into the house. These could be furnishings, artefacts, or articles associated with homeowner activities, especially hobbies or home occupations.

Drain Water Heat Recovery Performance Standard: CSA B55

The first edition of a standard for the testing and evaluation of efficiency and installation of drain water heat recovery units has been prepared and is now available for public review until December 25, 2011. There are two parts to the standard.

CSA B55.1: *Test method for measuring efficiency and pressure loss of drain water heat recovery units* specifies the requirements for measuring the efficiency of drain water heat recovery (DWHR) units. It sets out the test apparatus needed, which aim to simulate conditions in which DWHR units are installed and to standardize the testing conditions. It is only intended to rate the performance of vertically installed DWHR units with equal potable water and drain water flow rates.

Essentially, the test is taken at steady state conditions, which are estimated to take 2 to3 minutes and with a water temperature difference of 28°C between incoming and outgoing water at a flow rate of 9.5 litres per minute.

CSA B55.2: *Drain Water Heat Recovery Units* specifies health and safety requirements for drain water heat recovery (DWHR) units. It was developed in response to the need for a document that specifies safety and performance criteria for drain water heat recovery units. The Standard applies to the drain water heat recovery units, components and materials supplied by the manufacturer, the assembly and installation instructions, and the operation of the system after it has been assembled according to these instructions, but it does not apply to site preparation or installation procedures.

The standard requires that materials in contact with drain water must be a minimum thickness of Type DWV copper tube conforming to ASTM B 306. Materials in contact with potable water must be a minimum thickness of Type L copper tube, conforming to ASTM B 88. Any standard fittings used in the manufacturing of DWHR units must comply with ASME B16.22 or ASME B16.18. Connections between the coiled water supply tubes, and a fabricated manifold must be brazed using a filler metal with a melting point in the range of 590-815°C.

Copies of the draft standard can be accessed at: *https://review.csa.ca/oprdocuments/4457B55%20 Series_DraftJ_Oct2011_PR.pdf*

Comments should be sent prior to December 25, 2011 to: Lauro Pilla
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Canadian Home Builders' Association

Technical Research Committee News

Radon remediation

Radon is a colourless, odourless, naturally occurring radioactive gas that comes from the natural breakdown of uranium in soils and rocks. As the radioactive radon decays it produces decay products, sometimes called "radon daughters" or "radon progeny". Two of these progeny, polonium-218 and polonium-214 decay rapidly themselves, and emit alpha particles. When alpha particles hit an object, the energy in them is absorbed by the surface of the object. Human skin is thick enough to not be affected, but if you breathe in alpha particles, they can damage bronchial and lung tissue, and can lead to lung cancer.

It has been shown that radon poses a major lung cancer risk. It has been a factor in the incidence of lung cancer among uranium miners, but it has also been shown to be a concern due to radon levels found in some houses.

Recently, changes were made to Canadian radon guidelines, bringing them in line with international standards. Today, the guidelines suggest that remedial measures should be undertaken in a dwelling whenever the average annual radon concentration exceeds 200 Bq/m³ in the normal occupancy area (the area of the home where residents spend more than 4 hours a day).

The nature of radon is that there is no uniformity in radon levels between buildings. Just because one house has an issue, there is no certainty the neighbour will too. However, the geology of an area could indicate the potential risk for buildings in the region. That is why the National Building Code has introduced changes that will facilitate the remediation of a house in the event that radon is identified to be an issue, but does not automatically require it.

It is also important to stress that testing for radon must be done over a longer term – typically about one month or longer – and during the winter when the house is closed. Short-term tests do not provide an adequate picture.

Cross Canada Survey % of houses with high radon levels	
Alberta	6.9%
British Columbia	4.6%
Manitoba	23.5%
New Brunswick	17%
Newfoundland	5.3%
Nova Scotia	8.2%
North West Territories	4%
Ontario	4.9%
Prince Edward Island	4.5%
Quebec	9%
Saskatchewan	15.8%
Yukon	15.9%

How Big Is the Problem?

Health Canada has been conducting tests over the past couple of years. Results of radon testing in 14,000 houses across Canada have found that most health districts in Canada had at least some houses with higher radon levels. The national average is approximately 7% of houses with radon levels requiring remediation, although this varies considerably by region. Detailed data analysis and test results are to be published when they have been approved. However, interim data show that the highest numbers of houses with high radon levels are found in some regions. (see table).

Radon Remediation

Health Canada has prepared new documentation for both the homeowner and professionals. These include a Guide for Radon Measurement in Residential Buildings and a new mitigation guide (Reducing Radon Levels in Existing Homes: A Canadian Guide for Professional Contractors) which are available on the Health Canada website. These provide detailed practical information for contractors on all aspects of dealing with radon.

Radon concentration in living spaces can be reduced by:

Increasing the ventilation rate in the living space or adjacent spaces to dilute the radon as it enters.

Changing the internal air circulation patterns to intercept air containing radon before it enters the living space, and diverting it to the outdoors.

Decreasing the flow of soil gas into the house through the foundation by air sealing the foundation and by decreasing the pressure in the soil beneath the building so that soil gas won't flow from the soil into the building – this is where active sub-slab depressurization is used.

Health Canada will be encouraging all Canadians to test their houses. They are also providing information on mitigation strategies. They have already noted more public awareness of the issue, especially as the message is that if high radon levels are found, it can be fixed easily and at a reasonable cost.

In order to ensure that testing and remediation is done properly, there is a need for properly qualified specialists. Canadian certification will not be administered by Health Canada. Rather than developing a new certification program, Health Canada decided on working with an existing program, but with guidance and oversight from the government. Accordingly, an agreement has been signed with the National Environmental Health Association (NEHA-NRPP) in the US to establish a Canadian component of their program. NEHA-NRPP will act as the credentialing body, providing all program management services in accordance with their program procedures.

Health Canada will help with training curriculum development to ensure they are in accordance with Health Canada's radon guidelines and protocols, to Canadianize the materials, to translate materials into French, to develop Canadian-specific exams, and to assist NEHA-NRPP with competency assessment of radon measurement professionals by providing QA/QC oversight.

Some of the key features that differ in Canada from the US include different measurement units used in Canada (Bq/m³ compared to pCi/L in the US); the recommendation for long-term testing, which is not tied to real estate transactions, as well as differences based on Canadian geology and climate, and a competency assessment of professionals through a quality assurance and quality control program.

Delivery agents will be sought for these programs starting in the spring 2012. Distance learning is expected to be a part of the delivery strategy. Health Canada is looking to collaborate with builders on testing different mitigation strategies and in marketing these features. ✪

Contempra Cement: A Greener Shade Of Cement

Portland cement is an essential ingredient of concrete, which is perhaps the most important construction material we have. It gives us strong, durable elements used in all construction sectors.

Cement production is very energy intensive. When limestone, the main ingredient of cement, is heated, CO_2 is released. So the combustion gases used to fuel the kilns required to produce cement and that released by the limestone, make the cement industry the largest single industry responsible for a significant amount of man-made carbon dioxide emitted into the atmosphere. Global CO_2 emissions from cement production were estimated to be 3.4% of global emissions in 2001.

That is why there have been attempts to find alternate ways to manufacture concrete that will have lower environmental impact. One approach has been to use a mix of cement with fly ash collected from coal burning plants.

The Cement Association of Canada introduced a new variation to the Canadian market at the recent Greenbuild conference in Toronto. It will be marketed under the Contempra™ label.

Contempra is a new cement product that decreases CO_2 emissions by 10 per cent while still producing concrete with a level of strength and durability comparable to that produced with regular Portland cement. This is achieved by changing the mix used in the manufacturing process.

While regular Portland cement may contain up to five per cent limestone, Contempra is manufactured by grinding regular clinker (produced by heating the limestone) with up to 15 per cent limestone. By reducing the amount of clinker used in manufacturing cement, this process reduces the amount of energy and greenhouse gas emissions required to manufacture it. This is key since while cement typically represents only 11 per cent of a concrete mix, it accounts for more than 80 per cent of all energy required to produce concrete.

While new to the Canadian market, Contempra has an extensive proven track record in Europe — where it is known as Portland-limestone cement — in a variety of commercial and residential applications for over 25 years.

In 1965, Germany's Heidelberger Cement first developed a cement product with 20% limestone content. As more knowledge and experience was gained, other countries followed. Today, the European cement standard allows for Portland-limestone cement made with up to 35% limestone content, although the most popular cement in Europe today is Portland-limestone cement with a limestone content of up to 20%. The 15% limestone limit applied to Contempra cement in Canada is well within the maximum limit of 35%.

Contempra is included under the name Portland-limestone cement in the CSA cement and concrete standards, now referenced in the 2010 National Building Code of Canada and approved for use in British Columbia, Manitoba, Ontario, Quebec, and Nova Scotia. It will be approved for use in the other provincial jurisdictions once they adopt the 2010 NBCC or update their references to the current cement and concrete standards. ✪

Letters to the Editor

Re: Proper Detailing Does Matter: The Power of Water (Solplan Review 159, July 2011)

Having been in the deck and railing industry since 1988, my company has installed many different types and styles of guardrails. Before the "leaky condo" crisis on the West Coast, many metal railings were top-mounted and unfortunately, many without attention to detail and on decks and balconies with little or no slope or sloped in the wrong direction.

We have top-mounted metal railing systems that are still performing after 20-plus years.

There are 3 main elements critical to achieving a top-mounted railing system that works:

- the slope of the deck
- the fasteners used to secure the rail to the deck;
- the sealant used to seal the penetrations.

The mantra that only side-mounted guardrails will work was created primarily by the "leaky condo" crisis. Engineers decided, understandably and unilaterally, that to overcome bad construction practices and to fully protect themselves, side-mounted rails would be the only answer.

As with anything, there are pros and cons;

- Side-mounted rails are generally more expensive;
- The fascia is harder to maintain, i.e. cleaning and painting (see attached pictures)

They are, in many cases, busier looking and not aesthetically pleasing.

Now we have building inspectors requiring side-mounted rails and have the public believing it is a building code requirement - another incident of authority playing on the ignorance of the people. They even have many contractors, the uninformed ones, believing this. Certainly there are instances where side-mounted rails work best, but whatever happened to common sense when determining what type of system should or could be used?

Re: Green Insulation: Hemp Fibers (Solplan Review, September, 2011)

When discussing highly controversial issues, I believe in balance. Your comment that agricultural fibres lock up CO_2 during growth and will have a positive role to play in combating global warming is certainly one of those issues. Some prefer to call it climate change.

Also, I find your comment about the association of hemp with marijuana and that the puritanical mindset in North America today is possibly restricting the development and marketing of these types of materials here, offensive. I am far from puritanical and have definite convictions in this area.

Bart Blainey
ProDeck Ltd.
Victoria, BC

Regarding detailing of guardrails: I agree that top-mounted guardrails may perform well for a long time. However, the reality is that top mounting fasteners are a vulnerable detail. Proper sloping of the deck and use of appropriate fasteners should be standard.

However, reliance on sealants to seal the penetrations is a concern, because the sealant in the top is vulnerable to atmospheric conditions – ultraviolet, and extreme temperature variations that impose stresses on materials that will lead to ultimate failure. Even 'lifetime' materials will deteriorate over time. Building envelope professionals have been insisting on the side-mounted railing fastening because they are a more robust detail that will perform with less chance of deterioration even with a less than perfect installation or maintenance – and there is seldom perfection on the job site.

I see many designers coming up with totally inappropriate and difficult to construct designs with little thought about the detailing that may be required. When the design calls for decks and balconies, the design should take into account the necessary details that may be needed. Climate sensitivity should be a part of the design concept, and that may require special consideration for flashings, railing details, etc.

As an architect, I can appreciate the concern for aesthetics. At the same time, we may need to review our aesthetic attitudes. In wet climates, designs need to reflect the climate – and this means incorporating rain shedding details.

The Eiffel Tower was considered an eyesore when it was first erected, but today it is the symbol of Paris.

Re your comment about agricultural fibers for insulation – science has shown that plant fibres, especially trees, but also other plants, lock up atmospheric CO_2 which is a key contributor to climate change, and we have the science showing us that human activity has been the major contributor to this. In North America, industry and political forces have been working hard to deny the fact of global climate change and its consequences, to avoid having meaningful action being taken to change course.

Thanks for your comments. Ed.

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Advances in the Use of Vacuum-Insulated Panels (VIPs) in Buildings

By Wahid Maref

In previous issues of Solplan Review, the National Research Council's Institute for Research in Construction (NRC-IRC) reviewed the properties of Vacuum Insulated Panels (VIPs) (Figure 1), opportunities for their use in construction, and technical challenges that need to be overcome. With insulating values of R-60 per inch and higher, VIPs have the potential to significantly reduce building heating and cooling costs.

Figure 1. VIP sample

Recently, NRC-IRC hosted an international VIP symposium and completed a research project called Energy Performance of Highly-insulated Wood-frame Wall Systems Using VIPs. The purpose of this research was to develop recommended construction specifications and guidelines for assembling next-generation building envelope systems. The ultimate goal is to encourage their use in Canadian buildings, especially in wood-frame construction.

The scope of the project included constructing wall samples, performing thermal and air leakage tests on them and developing recommended details for highly insulated walls incorporating VIPs. Based on consultation with project partners and industry representatives, ten VIP configurations were developed based on double-frame walls with 2x4 studs on the exterior and 2x3 studs on the interior. The double wall allowed a number of combinations of VIPs and conventional insulations to be examined. It also provided maximum protection of the VIPs from construction activities (e.g., applying exterior cladding and interior finishes) and post-construction activities (e.g., installing shelving, hanging pictures, etc.). Two of the VIP configurations are shown in Figures 2 and 3.

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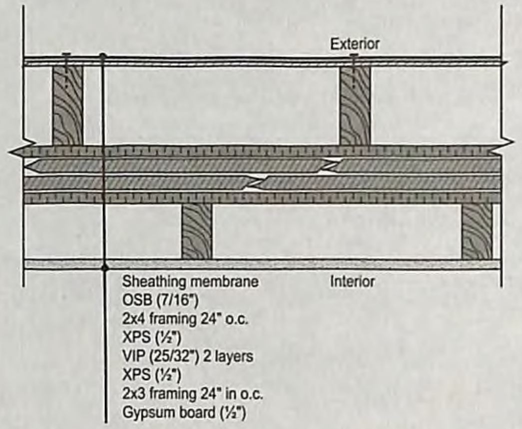


Figure 2. Wall Configuration 1A (two layers of VIPs encased in XPS insulation on both sides)

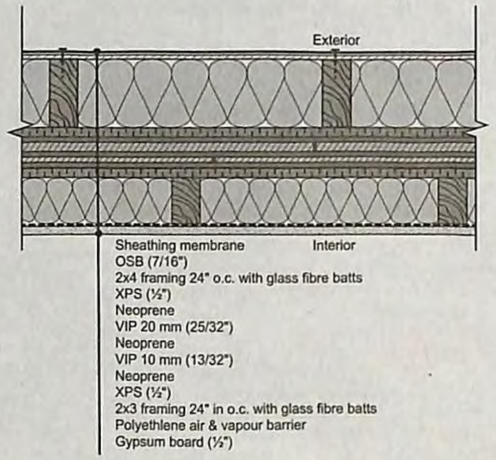


Figure 3. Wall Configuration 1G (two layers of VIPS separated by neoprene and with batt and XPS insulation on both sides)

All test walls (2.4 m by 2.4 m) were opaque with no penetrations or windows. Prior to thermal testing, the walls were subjected to cycles of positive and negative pressure to simulate wind conditions in service. Each wall was fitted with an array of thermocouples on both interior and exterior surfaces to measure surface-to¬-surface R-values. The R-values of all walls were determined in a guarded hot box facility. The thermal performance of the VIP walls was compared to a conventional 2x6 wall with batt insulation and polyethylene air/vapour barrier (Figure 4).

The reference wall had an R-value of 19.3 and the ten VIP walls had R-values ranging from 37.1 to 63.0. Although relatively thick (about 250 mm) compared to the 165-mm reference wall,

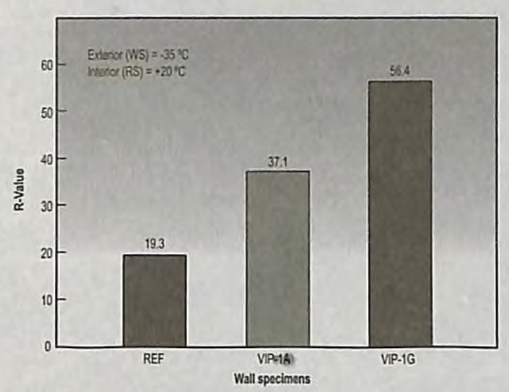


Figure 4. Thermal Resistance for Reference Wall, Wall VIP-1A, and Wall VIP-1G

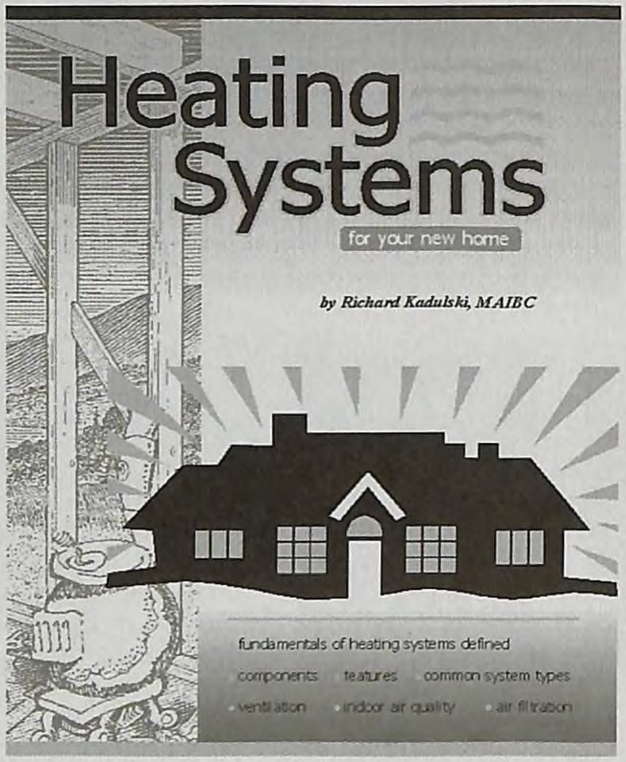
the double walls provide high insulating values. The conventional wall provides an R-value of 0.12 per millimetre of wall thickness, while the best-performing VIP wall provides an R-value of 0.252 per millimetre – twice that of the conventional wall.

The following observations from the project will be taken into account for future research and the move to commercial adaptation of VIPs:

- The choice of VIP sample sizes available from manufacturers was not optimal for typical North American wall construction. This should be addressed to reduce assembly costs.
- VIPs with square-edge insulation sandwiched first in thin neoprene layers and then extruded polystyrene layers seemed to be a feasible means for protecting VIPs during fabrication.
- Caulking between abutting VIPs stabilized the panels during installation, reduced air leakage and improved thermal performance.
- The wall panels were completely assembled and insulated in the horizontal position. Work is required to develop installation methods more representative of typical wood-frame wall construction.

This NRC-IRC research was one step in the development of next-generation building envelope systems. It identified VIP configurations that have potential for application and issues that require resolution before VIPs can gain greater market acceptance as a construction material. The VIP wall configurations are now being tested using the state-of-the-art NRC-IRC field exposure test facility for a one-year cycle of exposure to ¬natural climatic conditions (Figure 5). The results from this testing will be used to benchmark NRC-IRC's hygrothermal model, hygIRC-C. Thereafter, this model will be used to assess the performance of VIP wall configurations subjected to climatic conditions in various regions of North America.

Figure 5. (L) Preassembly of one VIP configuration and (R) field installation of one of the VIP configurations covered with exterior rigid insulation



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